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Spruce mortality in Yakutat Forelands - 1987

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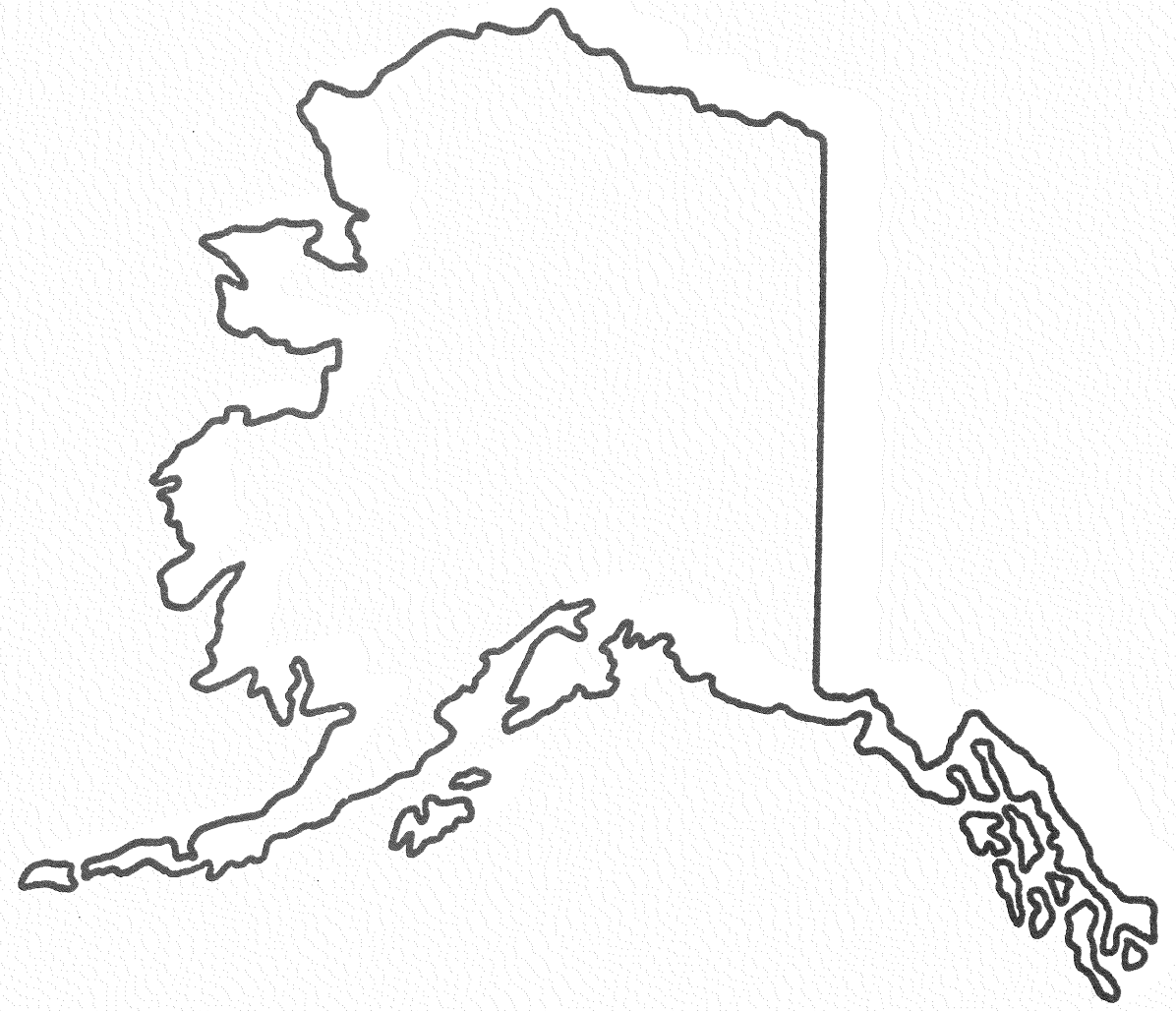

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BIOLOGICAL EVALUATION R10-88-2

SPRUCE MORTALITY IN YAKUTAT FORELANDS - 1987

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ABSTRACT

A severe windstorm produced extensive blowdown in Yakutat in the winter of 1981. Spruce beetle populations built up very slowly in the windthrown trees, and by 1985, some spruce mortality was noted in stands near the old blowdown units. Field work in 1987 revealed that about 16% of the trees had died in the most heavily affected stands. Annual beetle-caused mortality has been fairly constant since 1985, and nearly 10% of live and recently dead trees are currently infested. The beetles in these trees may kill additional spruces in the near future. It is recommended that the low-level beetle infestation be monitored closely.

INTRODUCTION

In the winter of 1981, a severe windstorm produced blowdown of timber on 3500 acres in the Yakutat Forelands. Over 100 million board feet of Sitka spruce (Picea sitchensis (Bong.) Carr.) and western hemlock (Tsuga heterophylla (Raf.) Sarg.) were windthrown in two large patches between the Dangerous River and Redfield Lakes (Figure 1). Since three-quarters of the windthrown material was Sitka spruce, there was concern that spruce beetle (Appendix A) populations could build to high levels in the blowdown and could subsequently threaten standing timber in the area. Evaluations were conducted by Forest Pest Management personnel in the summers of 1981, 1982, and 1983 in order to monitor spruce beetle populations and to keep forest managers informed of future problems (Eglitis 1982, 1984; Eglitis and Laurent 1983).

In the first summer after the windstorm, only 3% of the downed spruce were infested by the spruce beetle. By 1982, 19% of the downed spruce had been attacked, but brood production by the spruce beetle appeared to be very low. Populations in the down material remained low in 1983, and the likelihood of beetles moving into standing trees was thought to be minimal. In 1985, however, Forest Service personnel in Yakutat reported scattered dead spruce near the old blowdown areas, and the Forest Pest Management staff was asked to evaluate the situation.

The purpose of this report is to describe the results of field work done in the vicinity of the old blowdown units and to identify the potential for future spruce beetle problems in nearby standing timber.

METHODS

Spruce mortality was recorded onto 1:250,000 topographic maps during the pest detection aerial survey of the Yakutat Forelands area. In areas where tree mortality appeared to be the most concentrated, a subsequent ground evaluation was done using compass transects and prism cruising.

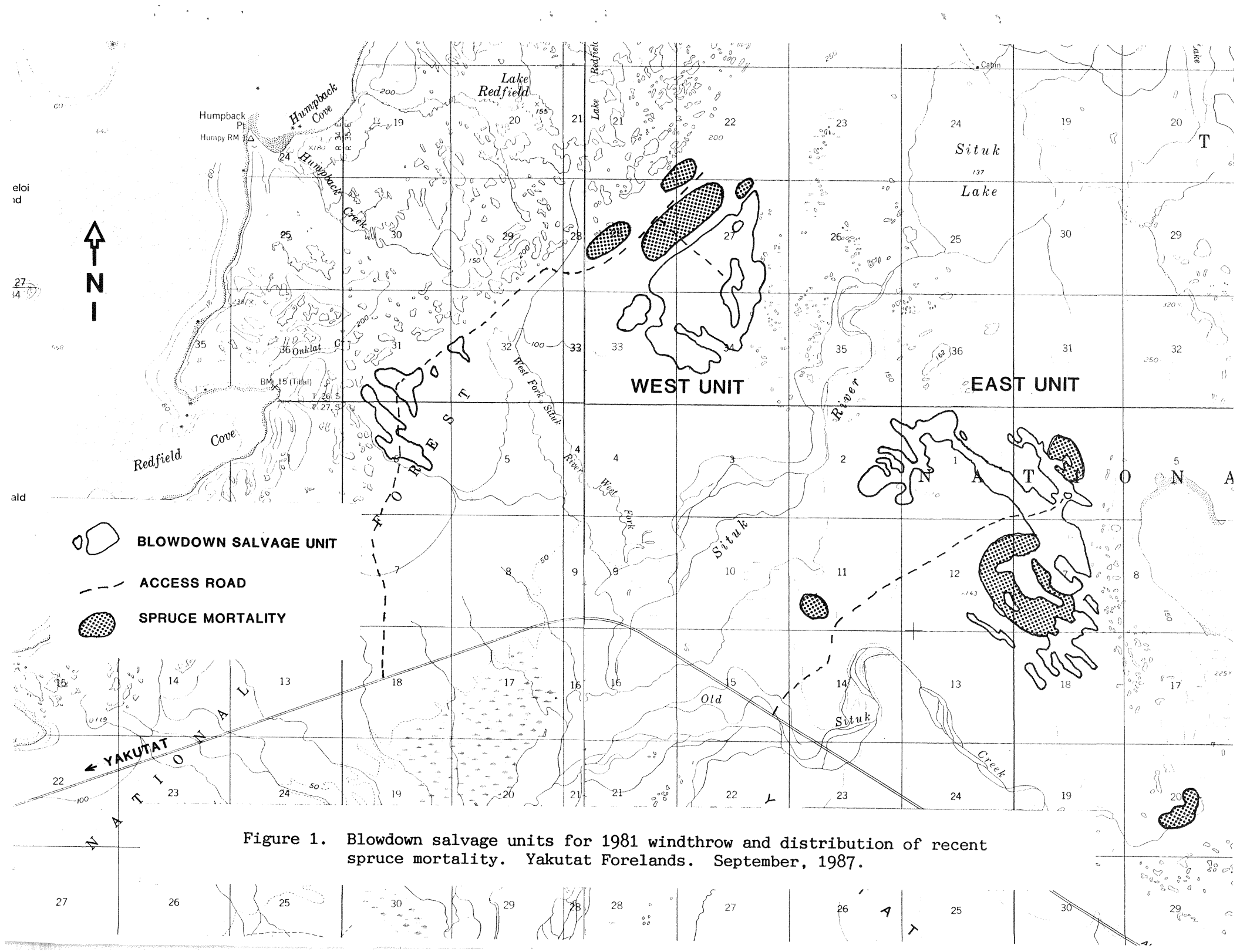

Figure 1. Blowdown salvage units for 1981 windthrow and distribution of recent spruce mortality. Yakutat Forelands. September, 1987.

Ground work was done near the two large salvage sale units on either side of the Situk River (Figure 1). Four transects were located near the West Unit, and five were near the East Unit (see Figure 2 for transect locations). We established variable radius plots at 3-5 chain intervals using a 20 BAF prism along each transect. At each prism plot, we recorded the tree species and estimated diameter at breast height to the nearest inch for all "in" trees. For each spruce, we recorded the tree condition and crown condition, examined for presence of bark beetle galleries or pitchouts, and estimated the year of death for each dead tree.

RESULTS AND DISCUSSION

In total, 815 standing trees were examined in the two areas. Sitka spruce represented 92% of the sample trees, with hemlock and cottonwood (Populus trichocarpa Torr. & Gray) making up 7% and 1% of the total, respectively. Stand information from the nine transects is shown in Figure 3 which combines data from the nine plot lines into two groups. In the West Unit, the average diameter of spruce was 17 $\pm$ 7" while hemlocks averaged 14 $\pm$ 9" dbh. Spruce in and around the East Unit averaged 21 $\pm$ 9" dbh, with hemlocks and cottonwoods averaging 15 $\pm$ 6" and 18 $\pm$ 2" dbh, respectively. Sixteen percent of the spruce were dead in the combined sampling transects. Mortality was comparable in the two areas with 18% of the spruce dead in the West Unit, and 15% dead in the East Unit. Spruce mortality was distributed equally throughout all the size classes (Figure 3), and the diameters of dead trees were not significantly different from the diameters of live trees. Most, but not all, of the mortality was attributed to the spruce beetle. In the West Unit, 44 of 59 dead trees (75%) had spruce beetle galleries in sufficient densities to consider the trees as beetle-kills. In the East Unit, 49 of 65 dead trees (75%) were probably killed by the spruce beetle. The cause of death of the other 31 trees is not known. Some dead trees contained ambrosia beetle or secondary bark beetle galleries, but the mortality agent was not apparent.

An attempt was made to determine the time of death of beetle-killed trees. Annual mortality rates of spruce could then be used to predict future spruce beetle activity. Of the 93 beetle-killed trees, 36 were killed in 1984 or earlier. Since that time, the annual mortality rate was fairly constant with 18 trees killed by the spruce beetle in 1985, 22 trees killed in 1986, and 17 trees killed in 1987. These numbers represent an annual mortality rate in the stand of 2-3% per year between 1985 and 1987. The mortality rates and the level of spruce beetle activity were very similar for both sampling areas.

Live spruce beetles were found in the 39 trees killed in 1986 and 1987 (5% of the stand). In addition, 26 live trees with strip attacks contained spruce beetle broods in the dead strips. The beetle broods in these 65 trees will become a source for infestation of new trees in the next two years. Of the live and dead infested spruce, 38 (5%) contain adult beetles ready to fly and attack trees in 1988, while 27 (4%) contain larvae which will not mature and attack until the summer of 1989.

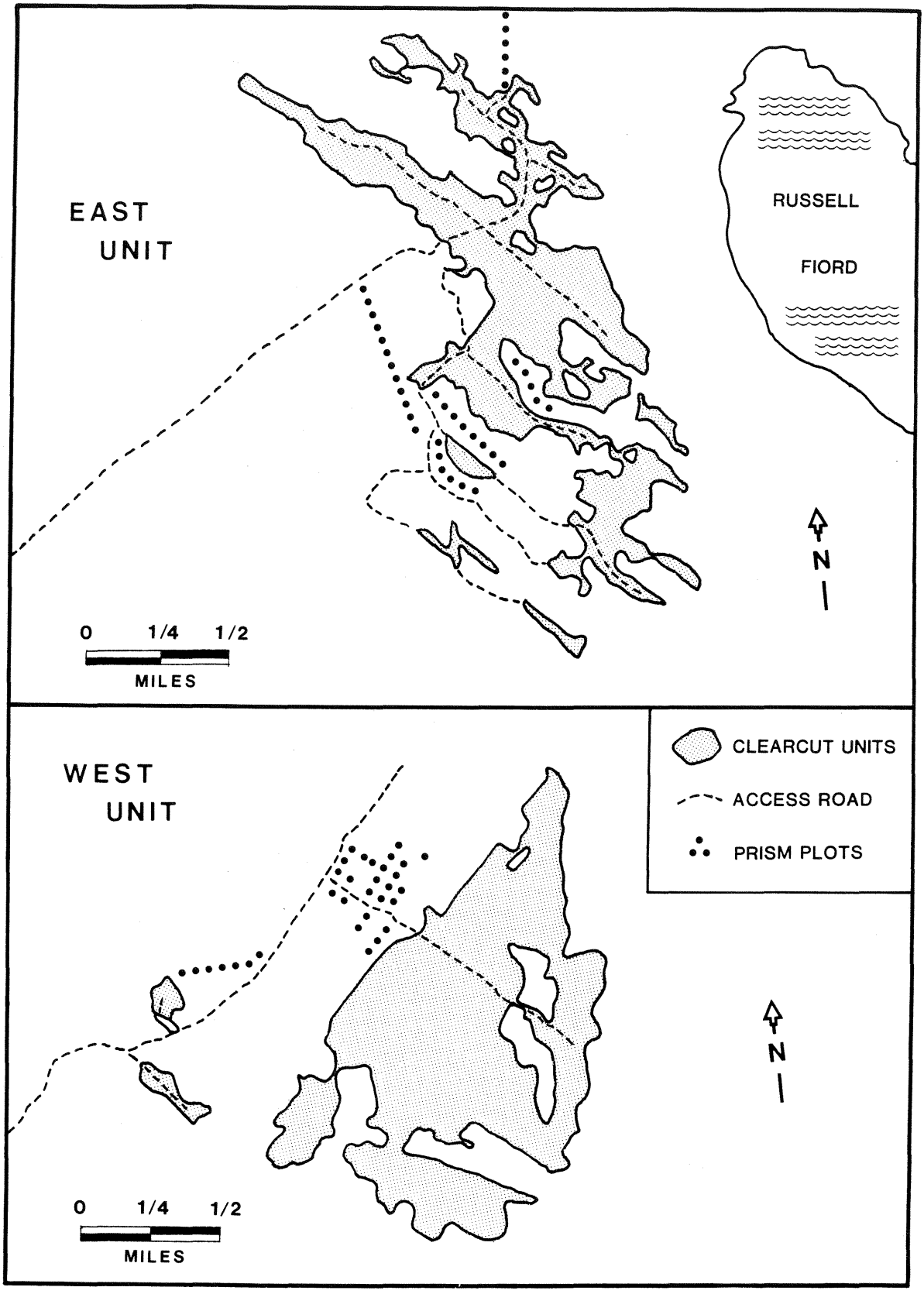

Figure 2. Locations of variable radius prism plots for assessing spruce mortality near two blowdown salvage units in Yakutat Forelands. September 1987.

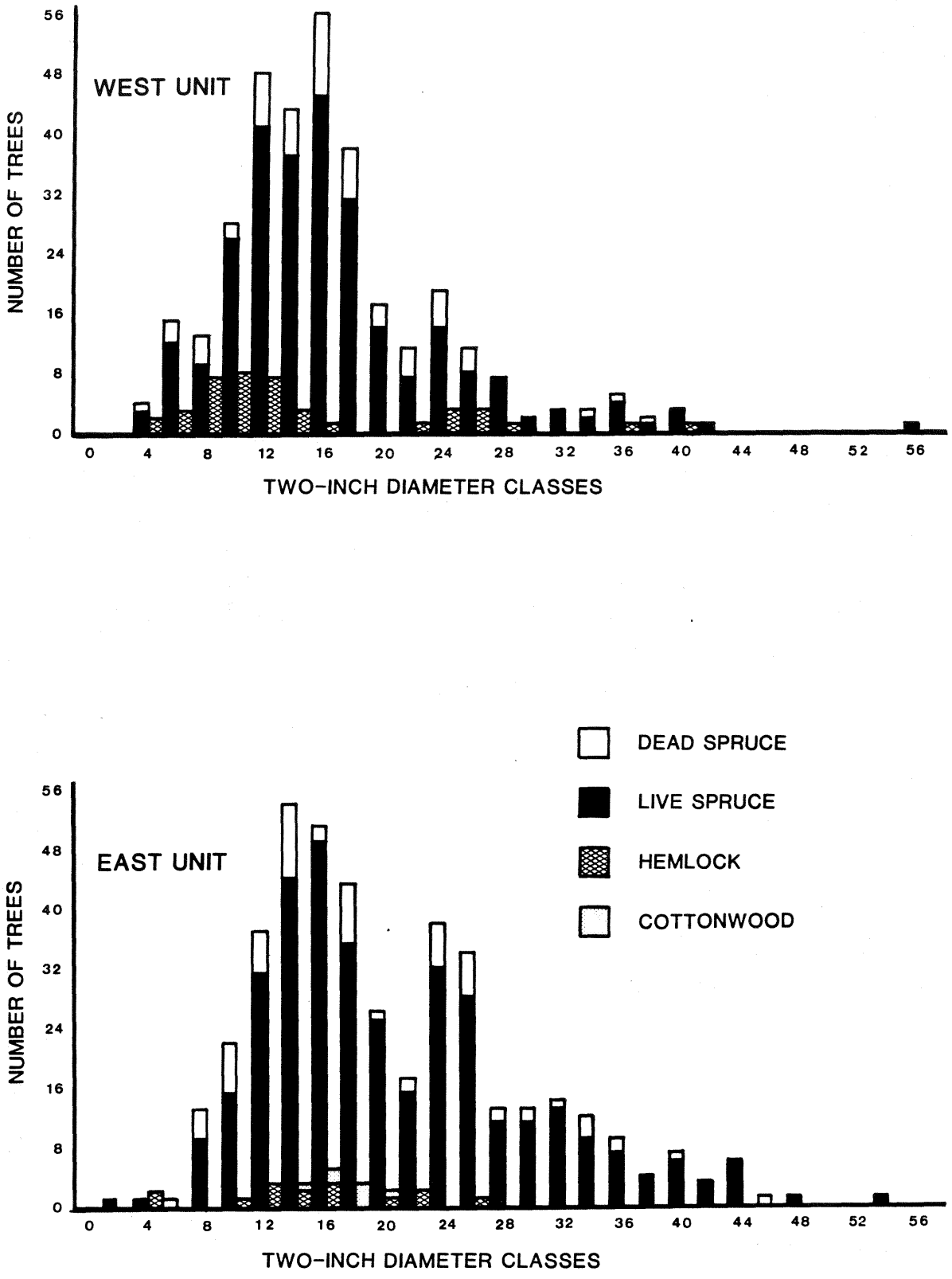

Figure 3. Diameter distributions of trees on variable radius plots in two sampling areas. Yakutat Forelands. September 1987.

Since mortality levels have been fairly constant over the past three or four years and since beetle populations are present in the area, it is expected that tree mortality may increase next year by another 3% to 5% in the areas sampled. The infestation could expand even more rapidly if warmer, drier summer weather prevails.

Future work

Nearly 10% of the live and recently dead trees have viable beetle broods which may continue to produce tree mortality in surrounding areas. Forest Pest Management staff will continue to monitor spruce mortality during the annual detection survey. In addition, it is recommended that the FPM staff install permanent monitoring plots in the Yakutat Forelands. Through aerial survey and yearly examination of the monitoring plots, any dramatic changes in beetle infestation levels could be detected and, if necessary, beetle suppression could be undertaken promptly.

MANAGEMENT ALTERNATIVES

Several management alternatives exist for dealing with the spruce beetle. Some of these alter the stand conditions which bring about beetle infestations, while others are simply directed at killing beetles. Some of the features of several approaches are briefly discussed below:

1. Maintain present management

The spruce beetle infestation would be allowed to run its course under this alternative. Beetle populations would eventually decline once the susceptible host material has been depleted, or if adverse weather prevails during adult dispersal. Changes in stand composition would occur, possibly to the benefit of certain wildlife species. Snags would eventually blow down creating openings in the canopy. These openings would probably be occupied by browse species or devilsclub, and less likely by new conifers. Some additional blowdown would also occur on the edges of these new openings, once again providing habitat for spruce beetles which prefer windthrown material to standing trees.

2. Chemical suppression

Some registered pesticides are available for treating bark beetle populations effectively. These can be remedial or preventive, but are costly and time-consuming since trees must be sprayed individually from the ground. The greatest utility of this method would be in protecting high-value trees near developed recreation areas.

3. Trap trees

This approach takes advantage of the spruce beetle's preference for downed material over standing trees. Green uninfested trees are felled to serve as an attractant to flying adults. Normally, one trap tree is felled for every four or five infested standing trees. Trap trees are felled prior to beetle flight,

and must be removed or treated within two years of felling, requiring a second entry into the treatment area. This method has been successful in campgrounds on the Chugach National Forest (Zogas 1987).

4. Lethal trap trees

In this approach which is similar to the other trap tree method, a silvicide is injected into uninfested standing trees. The trees are felled after the silvicide has been conducted into the tissues, and the bark beetle broods fail to develop after the initial attack. This procedure is less labor intensive that the standard trap tree method, since the infested material does not need to be removed.

5. Salvage logging

The harvesting of currently infested trees helps reduce the resident bark beetle population. Beetle broods can be destroyed through utilization of the infested material. Salvage logging would be selective, and would be most practical in conjunction with other harvesting in the immediate area of the infestation.

6. Silvicultural treatment

This method would attempt to create stand conditions that minimize tree mortality by spruce beetles. Susceptible trees could be thinned out to reduce competition and increase tree vigor in the residual stand. Thinning has been effective against Dendroctonus beetles in other parts of the country, and should work for the spruce beetle as well. The tradeoff for this alternative in Sitka spruce would be the increased risk of windthrow in the opened stand.

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APPENDIX A

Spruce beetle

Dendroctonus rufipennis (Kirby)
(Coleoptera:Scolytidae)

HOSTS: Engelmann, white, Sitka, and black spruce

DISTRIBUTION: Wherever spruce is found; a serious forest pest in south-central Alaska throughout Cook Inlet and Kenai Peninsula.

DAMAGE: Larvae feed beneath bark, usually killing affected trees.

DESCRIPTION: Adult spruce beetles are maroon to black, cylindrical in shape, approximately 5 mm long and 3 mm wide. Larvae are stout, white, legless grubs, 6 mm long when full-grown. The pupae are soft-bodied, white, and have some adult features.

BIOLOGY: The life cycle of the spruce beetle may vary from one to three years, with a two-year cycle being the most common. Temperature plays an important part in determining the length of time required for beetle development.

Adult beetles become active in the spring (late May -- early June) when air temperatures reach a threshold of 16°C (61°F). At this time, beetles emerge from trees in which they overwintered and fly in search of new host material. These dispersal flights may be short-range even though beetles are capable of flying for several miles without stopping.

Spruce beetles prefer to attack the sides and bottom surfaces of windthrown or other downed materials which have been on the ground less than one year. In the absence of such host material, large-diameter live trees may be attacked instead, and if beetle populations are high, these trees may be killed.

Beetle attacks, whether on windthrown or on standing timber, are mediated by pheromones which insure that individual trees will be attacked "en masse", and fully colonized by subsequent broods. Trees that are mass-attacked form attractive centers which result in groups of trees being killed by spillover attacks.

Female beetles initiate attacks and begin constructing an egg gallery in the cambium parallel to the grain of the tree. They are joined by males and after mating, lay eggs in small niches along the sides of the egg gallery. Most eggs will hatch by August.

As they feed in the cambium, larvae construct their own galleries perpendicular to the egg gallery. Normally, spruce beetles pass the first winter in the larval stage, resume feeding the next spring, and pupate by summer. About two weeks later, pupae transform into adults which pass the second winter, either in the old pupation site, or more commonly, in the bases of infested trees. The following spring, two years after initial attack, the new adults emerge and attack new host material. In some years when temperatures are abnormally high, or on certain warmer microsites, spruce beetles may complete their development within one season and new adults will emerge one year after attack.

Most major outbreaks of spruce beetle have originated from stand disturbances -- blowdown, logging, or right-of-way clearance. Stand susceptibility to beetle attack is influenced by stocking, with slow growth and moisture stress playing an important part in predisposing trees to attack.